Claims

What is claimed is:

1. Carbon nanofibers comprising fibrillated fibers having a Canadian Standard Freeness of less than about 100 or a fiber diameter of less than or equal to about 400 nm carbonized at a temperature of less than about 600°C.

2. Carbon nanofibers of claim 1 wherein said fibrillated fibers are activated in an oxidizing atmosphere at elevated temperature to form activated carbon nanofibers.

3. Carbon nanofibers of claim 2 further including a microbiological interception enhancing agent.

4. Carbon nanofibers of claim 2 wherein said activated carbon nanofibers can be formed into an activated carbon nanofiber sheet.

5. Carbon nanofibers of claim 1 wherein said carbon nanofibers can be formed into a carbon nanofiber sheet.

6. Carbon nanofibers of claim 1 further including a microbiological interception enhancing agent.

7. A filter medium comprising the carbon nanofibers of claim 1.

8. A sheet comprising fibrillated fibers having a Canadian Standard Freeness of less than about 100 or a fiber diameter of less than or equal to about 400 nm carbonized at a temperature of less than about 600°C.

9. A sheet of claim 8 wherein said sheet is further heated to form an activated carbon sheet having a BET surface area of greater than about 800 m^2/g.

10. A sheet of claim 8 wherein the fibrillated fibers have a Canadian Standard Freeness of less than about 45 or a fiber diameter of less than about 250 nm.

11. A sheet of claim 8 wherein the fibrillated fibers have a Canadian Standard Freeness of less than about 0 or a fiber diameter of less than about 250 nm.

12. A sheet of claim 8 wherein the fibrillated fibers comprise polymers, liquid crystal polymers, engineered resins, cellulose, rayon, ramie, wool, silk, or combinations thereof.

13. A sheet of claim 8 wherein the fibrillated fibers comprise lyocell.

14. A sheet of claim 8 further including active agents captured therein.

15. A sheet of claim 14 wherein the active agents comprise metals, metal salts, metal oxides, glass, alumina, carbon, activated carbon, silicates, ceramics, zeolites, diatomaceous earth, activated bauxite, fuller's earth, calcium sulfate, titanium dioxide, magnesium hydroxide, manganese oxides, magnesia, perlite, talc, clay, bone char, pitch, calcium hydroxide, calcium salts, or combinations thereof.

16. A sheet of claim 8 further including a microbiological interception enhancing agent.

17. A sheet of claim 8 wherein the fibrillated fibers are admixed with active agents, and made into a paper prior to carbonization.

18. A sheet of claim 8 wherein said sheet is used as an electrode.

19. A sheet of claim 8 further including a catalyst or a catalyst support.

20. A filter medium comprising the sheet of claim 8.

21. A sheet comprising activated, carbonized fibrillated fibers having a BET surface area of greater than about 800 m^2/g, wherein, prior to carbonization and activation, the fibrillated fibers have a Canadian Standard Freeness of less than about 100 or a fiber diameter of less than or equal to about 400 nm and wherein activation occurs in less than or equal to about 30 minutes at a temperature greater than about 875°C in an oxidizing atmosphere.

22. A sheet of claim 21 wherein the fibrillated fibers have a Canadian Standard Freeness of less than about 45 or a fiber diameter of less than or equal to about 250 nm.

23. A sheet of claim 21 wherein the fibrillated fibers have a Canadian Standard Freeness of less than about 0 or a fiber diameter of less than or equal to about 250 nm.

24. A sheet of claim 21 wherein the fibrillated fibers comprise polymers, liquid crystal polymers, engineered resins, cellulose, rayon, ramie, wool, silk, or combinations thereof.

25. A sheet of claim 21 wherein the fibrillated fibers comprise lyocell.

26. A sheet of claim 21 further including active agents captured therein.

27. A sheet of claim 26 wherein the active agents comprise metals, metal salts, metal oxides, glass, alumina, carbon, activated carbon, silicates, ceramics, zeolites, diatomaceous earth, activated bauxite, fuller's earth, calcium sulfate, titanium dioxide, magnesium hydroxide, manganese oxides, magnesia, perlite, talc, clay, bone char, pitch, calcium hydroxide, calcium salts, or combinations thereof.

28. A sheet of claim 21 wherein the fibrillated fibers are admixed with active agents, and made into a paper prior to carbonization and activation.

29. A sheet of claim 21 further including a catalyst or a catalyst support.

30. A sheet of claim 21 further including a microbiological interception enhancing agent.

31. A filter medium comprising the sheet of claim 21.

32. A sheet comprising carbonized fibrillated fibers having a Canadian Standard Freeness of less than about 45 or a diameter of less than or equal to about 250 nm, and active agents captured within said carbon sheet, said active agents present in an amount greater than about 10 weight percent of a total weight of said sheet.

33. A sheet of claim 32 wherein said active agents comprise metals, metal salts, metal oxides, glass, alumina, carbon, activated carbon, silicates, ceramics, zeolites, diatomaceous earth, activated bauxite, fuller's earth, calcium sulfate, titanium dioxide, magnesium hydroxide, manganese oxides, magnesia, perlite, talc, clay, bone char, pitch, calcium hydroxide, calcium salts, or combinations thereof.

34. A sheet of claim 32 wherein said active agents are present in an amount of greater than 50 weight percent.

35. A sheet of claim 32 wherein said active agents have a particle size of less than about 50 μm and are present in an amount of greater than 97 weight percent.

36. A sheet of claim 32 wherein said sheet is used as an electrode.

37. A sheet of claim 32 further including a catalyst or a catalyst support incorporated therein.

38. A sheet of claim 32 further including a microbiological interception enhancing agent.

39. A filter medium comprising the sheet of claim 32.

40. A sheet comprising activated, carbonized fibrillated fibers wherein the fibrillated fibers have a Canadian Standard Freeness of less than about 45, a diameter of less than or equal to about 250 nm, and active agents captured therein, wherein the active agents are present in an amount greater than about 10 weight percent of a total weight of said sheet.

41. A sheet of claim 40 wherein said active agents comprise metals, metal salts, metal oxides, glass, alumina, carbon, activated carbon, silicates, ceramics, zeolites, diatomaceous earth, activated bauxite, fuller's earth, calcium sulfate, titanium dioxide, magnesium hydroxide, manganese oxides, magnesia, perlite, talc, clay, bone char, pitch, calcium hydroxide, calcium salts, or combinations thereof.

42. A sheet of claim 40 further including a catalyst or a catalyst support.

43. A sheet of claim 40 further including a microbiological interception enhancing agent.

44. A filter medium comprising the sheet of claim 40.

45. A process of continuously making carbon nanofibers comprising the steps of:

providing fibrillatable fibers;

fibrillating the fibers to a Canadian Standard Freeness of less than about 100 or to a fiber diameter of less than or equal to about 400 nm, or both; and

carbonizing the fibrillated fibers at a temperature of less than about 600°C.

46. A process of claim 45 wherein the step of providing an organic fiber comprises providing organic fibers selected from the group consisting of polymers, liquid crystal polymers, engineered resins, cellulose, rayon, ramie, wool, silk, and combinations thereof.

47. A process of claim 45 wherein in the step of fibrillating, the fibers are fibrillated to a Canadian Standard Freeness of less than or equal to about 45 of a fiber diameter of less than or equal to about 250 nm.

48. A process of claim 45 wherein in the step of fibrillating, the fibers are fibrillated to a Canadian Standard Freeness of less than about or equal to about 0 or a fiber diameter of less than or equal to about 250 nm.

49. A process of claim 45 further including the step of activating the carbonized fibrillated fibers in an oxidizing atmosphere at a temperature of greater than about 875°C for less than or equal to about 30 minutes.

50. A process of claim 45 further including the step of treating the carbonized fibrillated fibers with a microbiological interception enhancing agent.

51. A process of claim 45 further including the step of adding gases during the step of carbonizing the fibrillated fibers such that functional groups are formed on a surface of the carbonized fibrillated fibers.

52. A process of claim 45 further including the step of incorporating a catalyst into the carbonized fibrillated fibers.

53. A process of continuously making a carbon sheet comprising the steps of:

forming a precursor paper from fibrillated fibers on a paper making machine wherein the fibrillated fibers have a Canadian Standard Freeness of less than about 100 or a diameter of less than or equal to about 400 nm; and

carbonizing the precursor paper to form a carbon nanofiber sheet, wherein the carbonization occurs at a temperature of less than about 600°C.

54. A process of claim 53 wherein the step of forming a precursor paper comprises forming a paper from fibrillated fibers having a Canadian Standard Freeness of less than about 45 or a fiber diameter of less than or equal to about 250 nm.

55. A process of claim 53 wherein the step of forming a precursor paper comprises forming a precursor paper from fibrillated fibers having a Canadian Standard Freeness of less than about 0 or a fiber diameter of less than or equal to about 250 nm.

56. A process of claim 53 wherein the step of forming a precursor paper comprises forming a precursor paper from fibrillated lyocell fibers.

57. A process of claim 53 wherein the step of forming a precursor paper further includes admixing the fibrillated fibers with active agents comprising metals, metal salts, metal oxides, glass, alumina, carbon, activated carbon, silicates, ceramics, zeolites, diatomaceous earth, activated bauxite, fuller's earth, calcium sulfate, titanium dioxide, magnesium hydroxide, manganese oxides, magnesia, perlite, talc, clay, bone char, pitch, calcium hydroxide, calcium salts, or combinations thereof.

58. A process of claim 53 further including the step of adding gases during the step of carbonizing the precursor paper such that functional groups are formed on a surface of the carbonized fibrillated fibers.

59. A process of claim 53 further including the step of activating the carbon nanofiber sheet by heating the carbon sheet at a temperature greater than about 875°C for less than or equal to about 30 minutes in an oxidizing atmosphere.

60. A process of making an activated carbon nanofiber sheet comprising the steps of:

forming a precursor paper of fibrillated nanofibers on a paper making machine wherein the fibrillated nanofibers have a Canadian

Standard Freeness of less than about 100, a diameter of less than or equal to about 400 nm, or a combination thereof;

carbonizing the precursor paper; and

activating the carbonized precursor paper in an oxidizing atmosphere at elevated temperatures to form an activated carbon nanofiber sheet.

61. A process of claim 60 wherein the steps of carbonizing and activating occur in a single heating step.

62. A process of claim 60 wherein the step of forming a precursor paper comprises forming a precursor paper from fibrillated lyocell fibers.

63. A process of claim 60 wherein the step of forming a precursor paper further includes admixing the fibrillated fibers with particles comprising one of carbon, activated carbon, inorganic particles, or a combination thereof.

64. A method of claim 60 wherein the step of activating the carbonized precursor paper occurs at a temperature of greater than about 875°C for less than or equal to about 30 minutes.

65. A process of claim 60 further including the step of adding gases during the step of carbonizing and activating the precursor paper such that functional groups are formed on a surface of the carbonized and activated fibrillated fibers.

66. A method of removing microbiological contaminants from a fluid comprising the steps of:

providing a filter medium having a microporous structure comprising carbonized nanofibers having a Canadian Standard Freeness of less than about 100 or a fiber diameter of less than or

equal to about 400 nm, wherein the nanofibers are carbonized at a temperature of less than about 600°C;

contacting a microbiologically contaminated fluid with the filter medium;

removing the microbiological contaminants in the fluid by adsorption and interception within the medium.

67 A method of claim 66 wherein in the step of providing a filter medium having a microporous structure comprising carbonized nanofibers, the nanofibers are treated with a microbiological interception enhancing agent.

68. A method of claim 67 wherein in the step of providing a filter medium having a microporous structure comprising carbonized nanofibers treated with a microbiological interception enhancing agent, the microbiological interception enhancing agent further includes a biologically active metal.

69. A method of claim 66 wherein in the step of providing a filter medium having a microporous structure comprising carbonized nanofibers, the carbonized nanofibers are activated.

70. A method of claim 69 wherein in the step of providing a filter medium having a microporous structure comprising a sheet of activated carbon nanofibers, the sheet further includes active agents captured therein.

71. A method of claim 66 wherein in the step of providing a filter medium having a microporous structure comprising carbonized nanofibers, the filter medium comprises a sheet of carbonized nanofibers.

72. A method of claim 71 wherein in the step of providing a filter medium having a microporous structure comprising a sheet of carbonized nanofibers, the sheet further includes active agents captured therein.

73. A method of claim 72 wherein in the step of providing a filter medium having a microporous structure comprising a sheet of carbonized nanofibers having active agents captured therein, the active agents comprise metals, metal salts, metal oxides, glass, alumina, carbon, activated carbon, silicates, ceramics, zeolites, diatomaceous earth, activated bauxite, fuller's earth, calcium sulfate, titanium dioxide, magnesium hydroxide, manganese oxides, magnesia, perlite, talc, clay, bone char, pitch, calcium hydroxide, calcium salts, or combinations thereof.

74. A method of claim 66 wherein the step of providing a filter medium having a microporous structure comprising carbonized nanofibers, the filter medium further includes active agents comprising metals, metal salts, metal oxides, glass, alumina, carbon, activated carbon, silicates, ceramics, zeolites, diatomaceous earth, activated bauxite, fuller's earth, calcium sulfate, titanium dioxide, magnesium hydroxide, manganese oxides, magnesia, perlite, talc, clay, bone char, pitch, calcium hydroxide, calcium salts, or combinations thereof.